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# Implementation of Parallel Redundancy Protocol in Intelligent Electronic Device

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**ABSTRACT:** This Design is a solution for high reliability, low-latency network communications for substation-automation equipment in smart grid transmission and distribution networks. It supports the Parallel Redundancy Protocol (PRP) specification in the IEC 62439 standard. PRP is a redundancy protocol for Ethernet networks (standardized using IEC 62439-3 Clause 4) that is selected as one of the redundancy protocols for substation automation in the IEC 61850 standard. PRP is application-protocol independent and can be used by most industrial-Ethernet applications that require reliable high-speed communications. The PRP supports star topology, which ensures a fixed-hop delay with cost of infrastructure. PRP operation over star topology. Once a packet is generated at Node 1, the same packet is sent through LAN A and B, and the destination (Node 3) receives duplicated packets if both deliveries succeed. The redundancy provides zero-recovery time if the packet fails to be delivered in one direction. A substation is a key component of the electricity-grid infrastructure, located everywhere from power generation facilities throughout the distribution network to the low-voltage feeders serving residences and businesses. Substations are a primary factor in transforming voltage levels for transmission and performing important functions such as switching, monitoring, and protecting sub-systems in order to maintain grid efficiency and reliability.

**KEYWORDS:** Relay, Arm processor, Prp, Ied's.

## I. INTRODUCTION

The main idea of this project is for some background, implementations of the substation communications standard IEC 61850 require a robust network designed with zero fail-over time. Two redundancy Architectures defined in IEC 62439-3 are Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR). Additionally, the 61850 digital substations require a high accuracy time source. Substation devices which synchronize to this time source expect the high accuracy time to be available regardless of network architecture. Our report sought to examine implementations of IEEE 1588 Precision Time Protocol and Power Profile operating in a Parallel Redundancy Protocol (PRP) network with multiple master clocks. We also intended to illustrate the challenge of providing both the high accuracy time source and network redundancy necessary for a robust digital substation. For this test setup, we connected two Intelligent Electronic Devices (IEDs) - a feeder protection relay and a line protection relay, two Ethernet switches in transparent clock mode, and two Global Positioning System (GPS) clocks configured as IEEE 1588 master clocks. Typically, PRP operates by having the IED send identical Ethernet messages from each of its PRP ports. The PRP-enabled IEDs then use the duplicate-discard method to determine which received message to use. We tested this configuration to see how IEDs handle receiving different, rather than identical, PTP messages on each of their PRP Ports.

## II. RELATED WORKS

The main idea of this project is for switching<sup>[1]</sup>, monitoring, and protecting sub- systems in order to maintain grid efficiency and reliability. PRP is defined in the international standard IEC 62439-3 and provides high availability in Ethernet networks. PRP implements redundancy by using PRP-enabled nodes (IACS devices) that

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send duplicate Ethernet frames to two fail-independent network infrastructures, known as LAN A and LAN B. PRP technology is well suited for variety of critical infrastructure IACS in process and heavy industries that require continuous, high availability operation. Advantages of using PRP over other network resiliency technologies includes

- i. No IACS data loss during a single fault in LAN A or LAN B. Protection against extended infrastructure failures in a single LAN (e.g., maintenance work, prolonged power outages, multiple network faults). Recovery after multiple faults in certain situations depending on the LAN topologies . Flexibility of allowing various network topologies, resiliency protocols, and IES platforms for each LAN . Ease of migration from non-Ethernet redundant media technologies such as Control Net Networks (not covered as part of PRP) Important factors when selecting PRP technology are support of PRP by IACS devices, possibility of building two independent network topologies without common faults, connectivity to non-PRP parts of the plant-wide or site-wide infrastructure, and proper configuration of other network services such as multicast management and time synchronization.

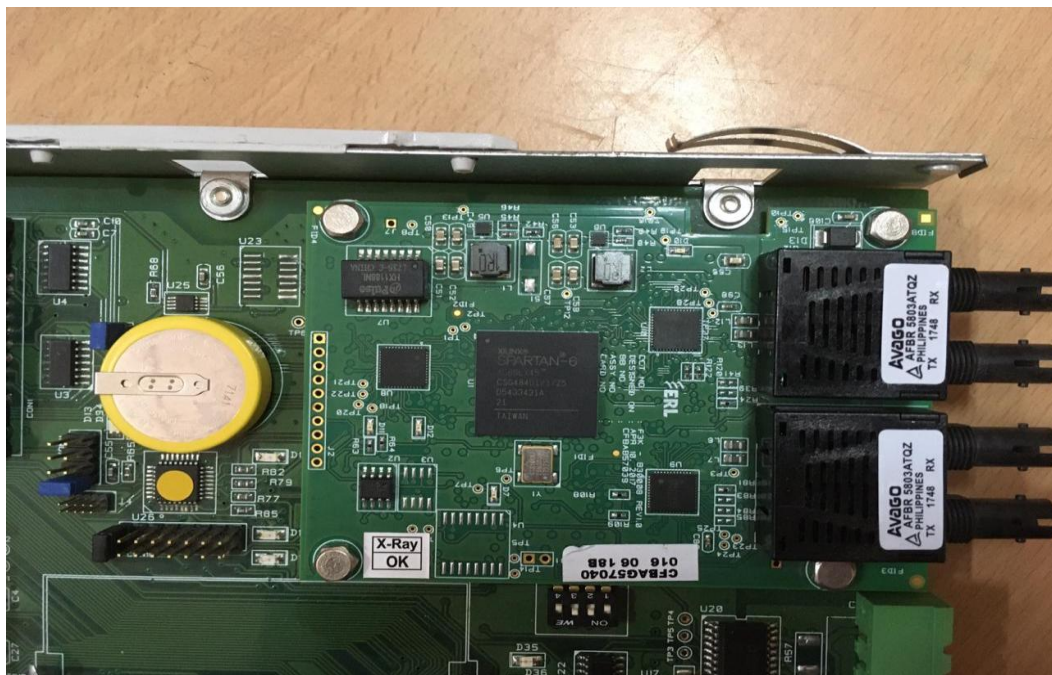


Fig.1.Top View Of Protection Relay

**International Journal of Innovative Research in Science, Engineering and Technology**  
*An ISO 3297: 2007 Certified Organization* Volume 9, Special Issue 1, March 2020  
**8<sup>th</sup> National Conference on Frontiers in Communication and Signal Processing Systems (NCFSPS '20)**  
**18<sup>th</sup>-19<sup>th</sup> March 2020**

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### III. BLOCK DIAGRAM

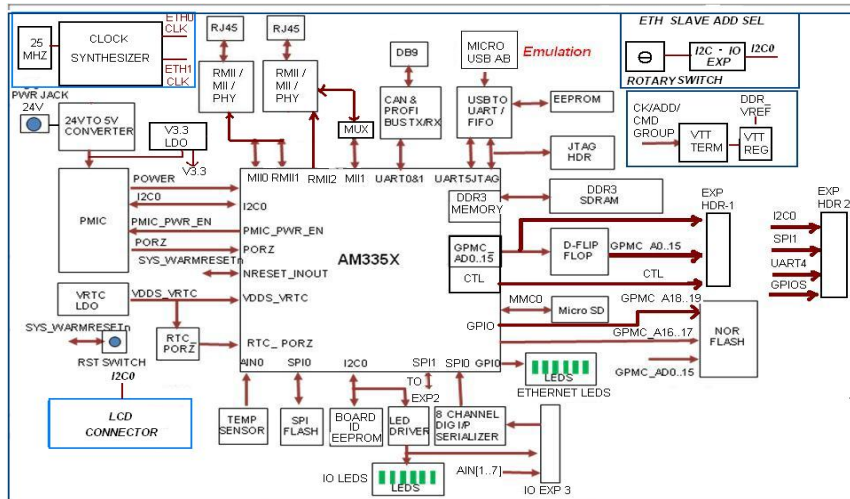


Fig 2. Block diagram of PRP

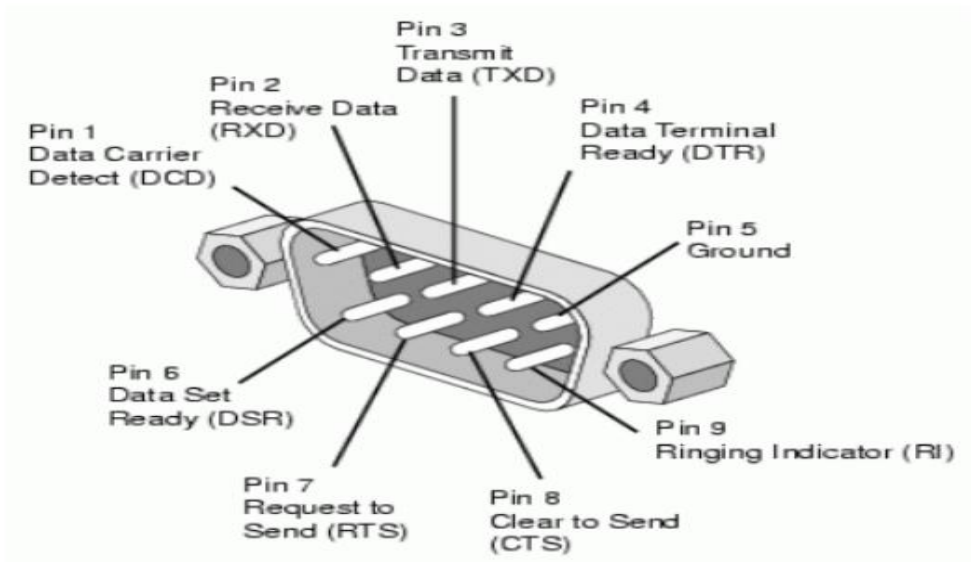


Fig.3. Pin description

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**IV. FLOW CHART**

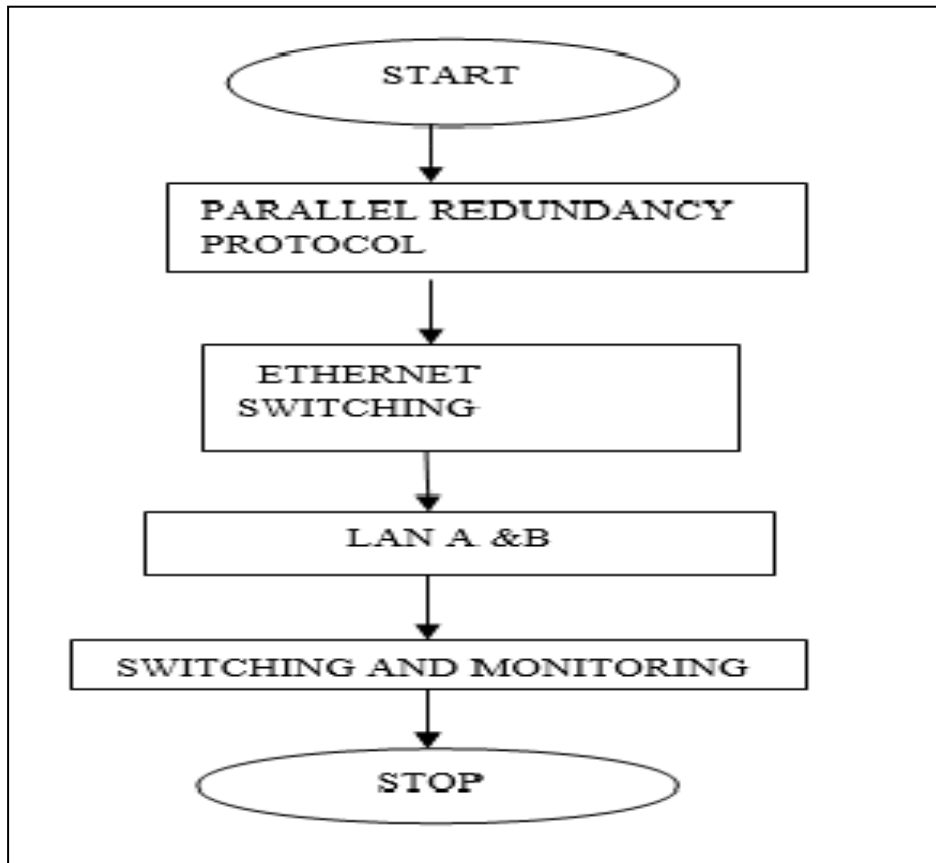


Fig.4. Flow chart

**V. 2X REAL TIME ETHERNET**

Ethernet was originally developed by Digital, Intel and Xerox (DIX) in the early 1970's and has been designed as a 'broadcast' system, i.e. stations on the Network can send messages whenever and wherever it wants. All stations may receive the messages, however only the specific station to which the message is directed will respond. The original format for Ethernet was developed in Xerox Palo Alto Research Centre (PARC), California in 1972. Using Carrier Sense Multiple Access with Collision Detection (CSMA/CD) it had a transmission rate of 2.94Mb/s and could support 256 devices over cable stretching for 1km. The two inventors were Robert Metcalf and David Boggs.

Ethernet versions 1.0 and 2.0 followed until the IEEE 802.3 committee re-jigged the Ethernet II packet to form the Ethernet 802.3 packet. (IEEE's Project 802 was named after the time it was set up, February 1980. It includes 12 committees 802.1 to 802.12, 802.2 is the LLC, 802.4 Token Bus, 802.11 Wireless, 802.12 100VG-AnyLAN etc.) Nowadays you will see either Ethernet II (DIX) (invented by Digital, Intel and Xerox) format or Ethernet 802.3 format being used.

The 'Ether' part of Ethernet denotes that the system is not meant to be restricted for use on only one medium type, copper cables, fibre cables and even radio waves can be used.

Ethernet uses **Manchester Phase Encoding (MPE)** for coding the data bits on the outgoing signal. The next few sections describe how Ethernet works and how Ethernet is structured.

## VI. DESCRIPTION

The AM335x microprocessors, based on the ARM Cortex-A8 processor, are enhanced with image, graphics processing, peripherals and industrial interface options such as Ether CAT and PROFIBUS. The devices support high-level operating systems (HLOS). Processor SDK Linux<sup>®</sup> and TI-RTOS are available free of charge from TI. The AM335x microprocessor contains the subsystems shown in the Functional Block Diagram and a brief description of each follows, The contains the subsystems shown in the Functional Block Diagram and a brief description of each follows, The microprocessor unit (MPU) subsystem is based on the ARM Cortex-A8 processor and the Power VR SGX<sup>™</sup> Graphics Accelerator .

The PRU-ICSS is separate from the ARM core, allowing independent operation and clocking for greater efficiency and flexibility. The PRU-ICSS enables additional peripheral interfaces and real-time protocols such as Ether CAT, PROFINET, Ether Net/IP, PROFIBUS, Ethernet Power link, Sercos, and others. Additionally, the programmable nature of the PRU-ICSS, along with its access to pins, events and all system-on-chip (SoC) resources, provides flexibility in implementing fast, real-time responses, specialized data handling operations, custom peripheral interfaces, and in offloading tasks from the other processor cores of SoC.

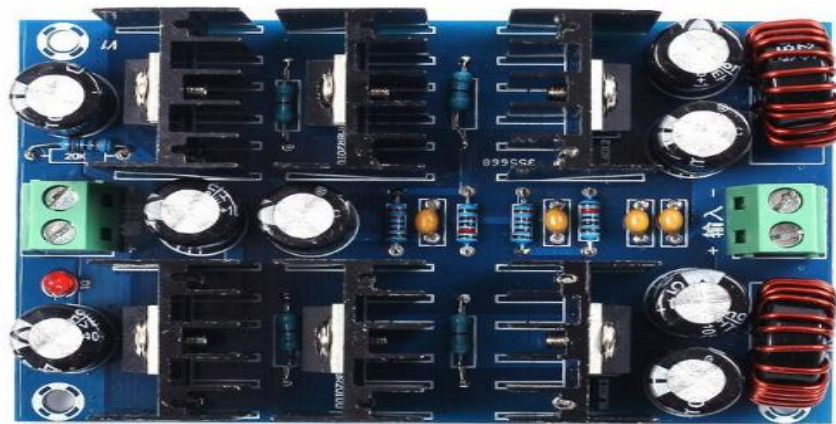


Fig.5 Power Supply Board

## VII. CONCLUSION

The "Parallel Redundancy Protocol" (PRP) according to IEC 62439-3 was designed for plain layer 2 networks to meet highest availability requirements due to its seamless redundancy. Applications like process bus in power utility automation or industrial motion control have these demands, which can not be fulfilled by standard reconfiguration redundancy technologies like MRP. Additionally the support of single attached non-PRP devices (SAN's) in the PRP network without additional components makes PRP more flexible in contrast to

HSR. It allows the use of low cost devices for uncritical communication without building another separate network infrastructure for these non PRP devices. All these advantages lead to the assumption that the seamless redundancy methods of IEC 62439-3 will soon gain widespread acceptance, since in the near future an increasing number of PRP and HSR devices will be. However, the current focus of PRP on plain layer 2 networks may be unsatisfactory for a range of applications. In this paper some network scenarios and related issues regarding PRP and IP Routing were highlighted. Different proposals of how PRP can also work between routed subnets were outlined. A proposal for a new PRPv2 was discussed in more detail and some light shed on its interoperability with PRPv1. To implement the proposed version, only a slight extension to the protocol trailer and some software extensions in the router are required. In fact, the PRPv2 capable router must become aware of PRP trailers on incoming packets and simply keep them with the routed packet on the outgoing interface without disturbing other protocols. Since these requirements for PRPv2 are not very demanding to implement, it would be very beneficial to include the proposed extensions in standardization and future implementation.

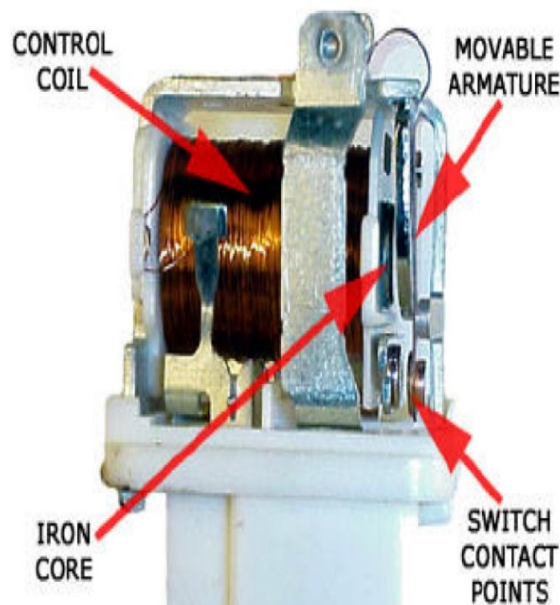


Fig.6 Relay Module

It is an electro-magnetic relay with a wire coil, surrounded by an iron core. A path of very low reluctance for the magnetic flux is provided for the movable armature and also the switch point contacts. The movable armature is connected to the yoke which is mechanically connected to the switch point contacts. These parts are safely held with the help of a spring. The spring is used so as to produce an air gap in the circuit when the relay becomes de-energized.

## VIII. RESULT

### A. Experimental output



Fig.7 Top view of output

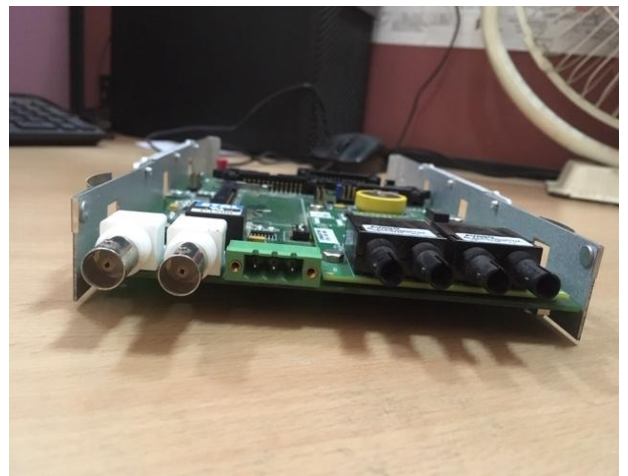


Fig.8.side view of the output

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